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NEW DIESEL ENGINE DEVELOPED BY USSR

Morskoy i Rechnoy Flot, No 7
Moscow, Nov 1953

The Soviet machine-building industry has developed a new diesel engine, the 8DR 30/50. This engine has been presented as the eight-cylinder model, for many stationary and ship installations, of the D and DR 30/50 types which were produced with four and six cylinders. It is designed for use on ships having direct engine-propellor drive.

The 8DR 30/50 is a vertical, two-cycle, single-action, trunk-piston, solid-injection (with jet fuel spray), direct-reverse engine.

The engine's technical characteristics are as follows:

Brake horsepower at 300 rpm	800
Number of cylinders	8
Diameter of cylinders	300 mm
Length of stroke	500 mm
Average piston speed	5 m/sec
Compression ratio	12.9
Average brake pressure	4.25 kg/cm^2
Average indicated pressure	5.64 kg/cm^2
Pressure on the compression stroke	34-37 kg/cm^2
Maximum ignition pressure	62 kg/cm^2
Minimum engine speed allowing continuous operation, at 40-60 brake horsepower	100 rpm

The engine's dimensions are as follows:

Length over-all	5,685 mm
Width over-all	1,615 mm
Height over-all	3,200 mm
Height from the bed plate flange	2,630 mm

The weight of the engine (without installation parts) is as follows:

Dry	25,000 kg max
With water and oil	26,000 kg max

Other specifications of the engine:

Length of service before capital repairs	8,000 hrs min
Fuel consumption at normal operating load	185 gr/brake hp-hr max

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Lubricating oil consumption at normal load	6 gr/brake hp-hr max
Fuel:	
Solar oil or Diesel oil	GOST 1666-51 / GOST 305-42
Lubricating oil:	
Motor T	GOST 1519-42

In many cases, automobile lubricating oil No 10 (GOST 1862-42) and diesel oil GOST 1600-46 can be substituted.

The new engine is being produced in both clockwise and counterclockwise models.

[See appended figures 1 and 2 for dimensions and cross-section views of the 8DR 30/50 engine.]

Construction of the 8DR 30/50 engine

The bed plate is a single iron casting. The frame bearing blocks are of steel, plated with BN-grade nickel babbitt. The block-crankcase is of cast iron, cast in two parts each housing four cylinders. The cast-iron cylinder liners are a wet, replaceable type.

The block-crankcase is connected to the base plate with bolts and short truss bolts. Both cylinder covers are one piece of cast iron resting on the liner and are connected to the block with eight pins each. The crankshaft is a seamless steel forging with an attached shaft for the scavenging air pump. The connecting rods are round steel forgings, center-drilled to allow passage of lubricating oil to the rod-end bearings. The permanent upper end is fitted with a pressed bronze bushing. The removable lower rod end is in two parts, which are fabricated of steel plated with grade B-83 babbitt. The pistons are one piece castings of cast-iron alloy, noncooled, with five compressor rings and two oil rings. The piston pins are a floating type. The blow-off system is the transverse port assembly developed by the Russkiy Dizel' Plant.

The fuel system is made up of one low-pressure fuel pump, an individual fuel injection pump for each cylinder, closed-type jets, a coarse-fuel filter, and a double-fine filter, using a felt-ring and port assembly. The fuel injection pumps are high-pressure pumps, made up of a steel housing connected to a cast-iron bracket. Within the housing, there is a pump liner and plunger, an automatic intake valve, a cam-controlled exhaust valve, and a safety valve. The pump plunger is set in motion by a cam plate of symmetrical shape, thus making unnecessary the reversing of the main fuel pump. The inlet valve also serves as a bypass valve; therefore, the amount of fuel delivered by the pump is controlled at the beginning of injection. The injection nozzle is oil cooled. The nozzle jet is perforated, and pressure on the open nozzle needle is 220 kilograms per square centimeter. A slit filter is fitted into the nozzle body.

The engine governor, located at the end of the camshaft, is centrifugal and single action. A change in engine speed is achieved by use of the fuel-pump control lever.

The starting system employs compressed air under a maximum pressure of 30 atmospheres. The starting system is a combination type, i.e., the starting air is introduced simultaneously with fuel. Reversing the engine is accomplished by a change of direction in the air supply.

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Lubrication for the crank-pin bearings, the crankshaft journal bearings, the connecting-rod upper ends, the camshaft and drive, the fuel-pump drive, and other parts is circulated by a reversing gear pump. Lubrication for the cylinders, scavenging-pump bearings, compressor cylinder, water-pump drive, and air distributor is delivered by five high-pressure lubricators.

Included in the circulating oil system are a coarse-mesh filter and a fine filter fitted with an ASFO-1 element. With this system in operation, lubricating oil may be used for a period of 500 hours while the filter elements can be used for 100 hours.

The oil cooler is of ordinary tubular design. In order to improve the heat carry-off and reduce the weight of the cooler, an assembly of alluminum diaphragms has been installed in the pipes.

The engine is cooled by water circulated by a piston pump attached to the engine. The pump is double action and is started from the crosshead of the scavenging pump with the aid of a balance.

The scavenging pump is a tandem piston type with slide-valve distribution. The pump cylinder is divided into two sections, each section working as an individual double-action pump. A single-step compressor is mounted on the upper pump cover to supply air to the starting tanks. The compressor piston is connected to the scavenging-pump rod and when the engine begins operating the compressor is set in motion. The compressor automatically maintains a pressure of 30 kilograms per square centimeter in the starting tanks.

Performance of the 8DR 30/50 Engine in Trials

The 8DR 30/50 engine ran a total of 2,755 hours in final tests. Of this, 623 hours were in preliminary tests, 505 hours in interdepartmental tests, 1,527 hours in plant tests after installation of low-alloy cast-iron pistons, and 100 hours in control tests.

Under all conditions, the 8DR 30/50 operated smoothly and reliably fulfilled technical specifications according to all parameters.

Fuel consumption at idling speed of 190 revolutions per minute was 17.4 kilograms per hours. With the engine in reverse at an output of 400 brake horsepower and a speed of 240 revolutions per minute, the fuel consumption was 189.6 grams per brake horsepower-hour. With the engine operating at 300 revolutions per minute and 800 brake horsepower, the exhaust back pressure reached 403.3 millimeters of water column and the scavenging air pressure reached 141.4 millimeters of mercury column.

Engine starting was accomplished by the use of three compressed-air tanks with an aggregate capacity of 600 liters under a pressure of 30 kilograms per square centimeter. Air expenditure for one start (without calculating leakage or temperature fluctuations) was 790 liters (reduced to one kilogram per square centimeter at surrounding temperature), or .99 liters per horsepower, or 2.79 liters per liter capacity of the engine cylinder.

The engine was reversed from these same air tanks. From an original pressure of 30 kilograms per square centimeter to 7 kilograms per square centimeter (the minimum pressure at which reversal was still possible), the engine was reversed nine times. The average time required for reversing was 6-7 seconds. The average expenditure of air for one reversal was about 1,533 liters.

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The minimum steady number of revolutions of the engine under a minimum load of 60 brake horsepower was 100 per minute; the minimum possible was 75 revolutions per minute.

The consumption of circulating lubricants was .586 kilograms per hour or .73 grams per brake horsepower-hour, and the consumption of forced lubricants was .774 kilograms per hour or .97 grams per brake horsepower-hour. Thus the total consumption was 1.70 grams per brake horsepower-hour.

The wear on crankshaft journals and crankpins after 2,754 hours of operation is shown in Table 1.

The maximum wear on the main bearings (plated with BN-grade babbitt) after 2,754 hours of operation was .49 millimeters, and the minimum was .01 millimeters. The average maximum wear for all nine bearings after 2,754 hours of operation was .21 millimeters.

The maximum wear of the connecting-rod bearings (plated with grade B-83 babbitt) after 1,152 hours of operations was .07 millimeters, and the minimum was .00 millimeters.

The piston pins are a floating type fabricated from grade 20 steel, with working parts case hardened and quenched to a hardness of 58-62 on the Rockwell C scale. The maximum wear on these pins after 1,152 hours of operation was .05 millimeters.

The maximum wear on the connecting-rod upper-end bushing (made of grade OF 10-1 bronze) after 1,152 hours of operation was .08 millimeters and after 2,754 hours it reached .27 millimeters.

The length of service for a cylinder liner was 6,000-12,000 hours, or an average of 9,000 hours.

Table 2 gives the average wear on the rings, increase in their gap size, and loss of weight after 1,152 hours of operation.

During preliminary trials of 505 hours, the engine broke down as a result of the formation of cracks on the surfaces and edges of the piston bottoms. This same defect has developed in engines with four and six cylinders of the D and DR series. The shipyard immediately began research on this problem. They compiled data on piston temperatures, examined materials taken from defective pistons, and conducted experiments in making heat-resistant cast-iron alloys.

The temperature differential between the edge and the center of the piston bottom was found to be 140 degrees centigrade. The maximum temperature on the side surfaces of the first piston ring was at least 350 degrees centigrade, while the maximum at the edge of the fifth compressor ring was as low as 240 degrees centigrade.

The data compiled in these tests allowed the shipyard to make two basic conclusions:

(1) The appearance of cracks was not due to pressures from the high temperature differential, since the temperature differential on the piston bottom was relatively light -- 140 degrees centigrade over a length of 150 millimeters or about one degree centigrade per millimeter.

(2) The temperature in the center of the piston bottom exceeds 500 degrees centigrade; thus, during extended operations the pearlitic structure of ordinary cast iron will break down. As a result, the cast-iron crystals enlarge and microscopic cracks appear which develop further under the influence of high-temperature oxidizing gases.

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Quantities of materials were recommended and tested for use in the pistons, and on the basis of these trials a cast iron was developed in alloy with chrome (.35-.46 percent) and nickel (.3-.33 percent) which was heat resistant and would thus prevent the formation of cracks.

With pistons made from the new alloy, the engine operated 1,527 hours with one dismantling to inspect the pistons. The average wear on these pistons after 1,152 hours of operation was .022 millimeters with a maximum wear on any one piston of .09 millimeters.

/See tables on following pages./

Table 1. Engine Wear (in millimeters) of 8DR 30/50

No	Crankpins						Main Crankshaft Journals					
	Maximum		Minimum		Average		Maximum		Minimum		Average	
	Verticle	Horizontal	Verticle	Horizontal	Verticle	Horizontal	Verticle	Horizontal	Verticle	Horizontal	Verticle	Horizontal
1	0.18	0.14	0.01	0.025	0.12	0.098	0.08	--	0.02	---	0.04	--
2	0.13	0.15	0.06	0.04	0.107	0.11	0.04	0.025	0.02	0.00	0.03	0.015
3	0.21	0.15	0.03	0.02	0.13	0.10	0.10	0.07	0.02	0.02	0.05	0.04
4	0.17	0.125	0.025	0.035	0.11	0.083	--	0.04	--	0.00	--	0.027
5	0.155	0.12	0.03	0.03	0.11	0.09	0.07	0.05	0.01	0.00	0.043	[illegible]
6	0.11	0.13	0.04	0.03	0.083	0.09	0.08	0.09	0.06	0.02	0.07	0.063
7	0.13	0.14	--	0.01	0.125	0.083	--	0.06	---	0.02	--	0.04
8	0.155	0.18	0.04	0.03	0.111	0.027	0.10	0.09	0.01	0.01	0.05	0.043
9	--	--	--	--	--	--	0.04	0.04	0.02	0.00	0.03	0.016
Over-all average	0.155	0.142	0.03	0.027	0.112	0.098	0.073	0.058	0.023	0.009	0.045	0.034

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Table 2. Wear on Rings of 8DR 30/50

Ring Number	Average Wear of Rings for All Cylinders (in millimeters): Radial Thickness: Maximum	Minimum	Average	Height: Maximum	Minimum	Average	Gap Increase (in millimeters): Maximum	Minimum	Average	Average Weight Loss (in grams)
1	0.284	0.034	0.186	0.011	0.001	0.006	0.9	0.3	0.53	7.885
2	0.160	0.051	0.095	0.027	0.003	0.015	0.7	0.0	0.35	6.305
3	0.095	0.023	0.060	0.009	0.0006	0.004	1.2	0.2	0.53	3.805
4	0.194	0.050	0.120	0.022	0.0006	0.006	0.95	0.15	0.57	6.998
5	0.291	0.122	0.200	0.022	0.002	0.007	1.45	0.35	0.66	8.604

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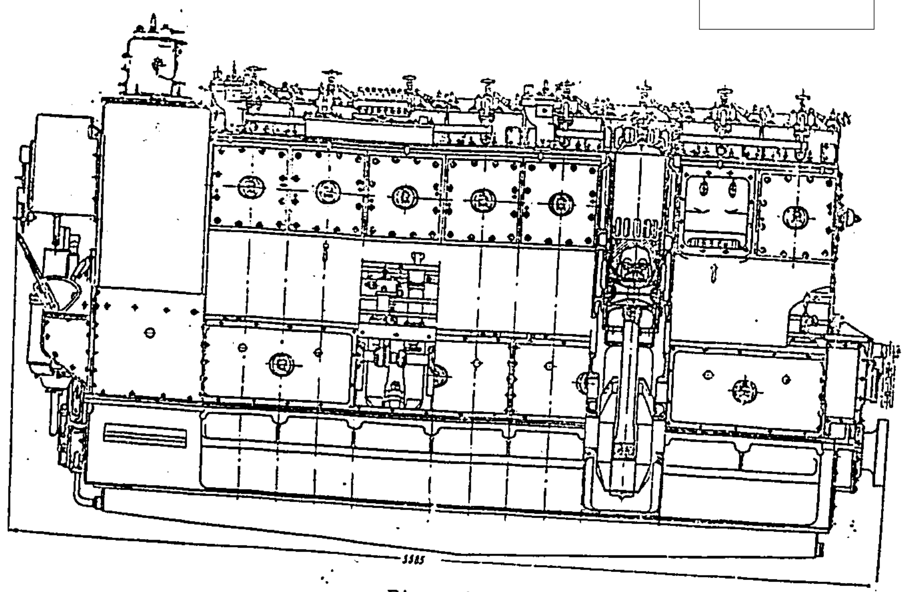

Figure 1

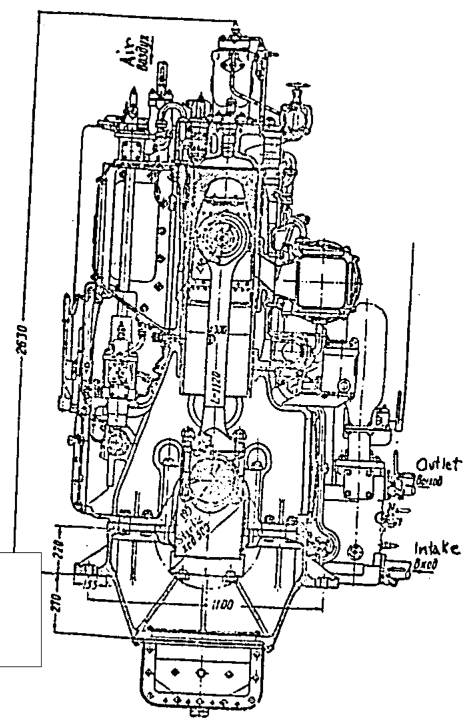

Figure 2

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